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Research Article

Effect of Intigrenated Phosphorus Management on Biochemical Properties of Soil under Soybean Crop

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Abstract: A field experiment was conducted at PGI, farm of Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (Maharashtra) during *kharif* season of 2011 using randomized block design with three replication and nine treatments in *Vertic Haplustepts* Inceptisol soil to study the influence of integrated phosphorus management on microbial population and soil enzyme activities under soybean crop. The treatment application of manures and fertilizers as per STCRC equation (yield target 25 q ha^{-1}) with FYM to soybean recorded significantly highest bacterial (31.03 x 10^6 cfu g^{-1} soil), actinomycetes (15.47 x 10^4 cfu g^{-1} soil), PSB (22.55 x 10^4 cfu g^{-1} soil) and fungi population (13.48 x 10^5 cfu g^{-1} soil), respectively with significantly highest (27.94 µg TPF g^{-1} soil 24 hr^{-1}) DHA at soybean harvest. However, at all critical growth stages of soybean, The treatment application of manures and fertilizers as per STCRC equation (yield target 25 q ha^{-1}) with FYM to soybean was significantly superior over all rest of the treatments in respect of both acid and alkaline phosphatase activity. The value of acid and alkaline phosphatase in these treatment are 17.97, 20.72, 17.85,14.91 and 55.28, 66.48, 57.54 and 34.39 µg PNP g^{-1}soil hr^{-1} under soybean growth stages *viz.*, 3rd trifoliate, 50% flowering, pod filling and at harvest, respectively. However, the highest DHA, acid and alkaline phosphatase activities in soybean was observed in the same treatment and occurs the highest rate at 50% flowering stage of soybean.

Key words: Integrated phosphorus management, bacteria, actinomycetes, PSB, fungi, dehydrogenase, acid and alkaline phosphatase.

INTRDUCTION

Soybean with an area of about 10 million hectare and production over 12 million tonnes is the most important oilseed crop. Soybean, being the richest, cheapest and easiest source of best quality proteins (40%) and fats. It builds up the soil fertility by fixing large amounts of atmospheric nitrogen through root nodules. Phosphorus (P) is a major nutrient element in legume nutrition, as it is involved in several energy transformation and biochemical reactions including biological nitrogen fixation. Microorganisms play key role in phosphorus availability to plants through mineralizing organic P in soil and by solubilising precipitated phosphates[1].

The population and functions of microorganism cannot be over-locked while considering the soil health because microorganisms provide live environment to the soil and perform various functions like transformation of nutrients to usable forms, decomposition of organic residues, biochemical activities and enzymatic activities. Soil enzyme activities are 'sensors' of soil degradation since they integrate information about microbial status and physic-chemical conditions of soil in relation to nutrients availability [2]. The organic manures are the testimony of valuable role of organic matter in maintaining a good health of the soil in terms of improving physic-chemical properties, microbial population and their activities and increasing nutrient availability to the crop plant. Saha *et al.*[3] showed that the nature and amount of organic fertilizers applied to the soil significantly affect phosphatase activity and available phosphorus. Generally addition of organic manures with inorganic fertilizers had the beneficial effect in increasing the P availability. Therefore, the present work was undertaken to study the impact of different organic manures as nutrient sources in the soil with special reference to soil enzymes as soil health indicators under field experiment with soybean.

MATERIALS AND METHODS

A field experiment was conducted during Kharif season of 2011 at the Post Graduate Research farm of Mahatma Phule Krishi Vidyapeeth, Rahuri. The soils was Clayey having medium in organic carbon (0.59%), low available N (166.20 kg ha^{-1}) and available P (13.78 kg ha^{-1}) and very high (365.90 kg ha^{-1}) available K with alkaline pH 8.27 and EC 0.23 dSm^{-1}. Initial microbial population content were bacteria (x cfu 10^6 g^{-1}soil) 8.20, Fungi (x cfu 10^5 g^{-1}soil) 2.50, Actinomycetes (x cfu 10^5 g^{-1}soil) 3.90, PSB (x cfu $10^4$$g^{-1}$soil) 5.0 and enzyme activities *viz.*, dehydrogenase (µg TPF g^{-1} soil 24 hr^{-1}) 6.18, acid and alkaline Phosphatase (µg PNP g^{-1} soil hr^{-1}) 7.92 and 31.82, respectively. Experiment was laid out with nine treatment combinations in randomized block design and plot sizes of 5.10 x 4.50 m^2 with three replications to soybean (T_1- Absolute control, T_2- As per soil test crop response correlation (STCRC) equation (yield target 25 q ha^{-1}) without Farm Yard Manure (FYM), T_3- As per STCRC equation (yield target 25 q ha^{-1}) with FYM, T_4- As per soil test (AST) RD NK+P (SSP). The treatments T_5 to T_9 are AST RD NK + 25% P_2O_5 substitute through FYM, Poultry manure, vermicompost, Pressmud compost and Neem cake + 75% SSP, respectively. While applying NPK through chemical fertilizer to soybean NPK content of inorganic manures were considered. Soybean was sown at 30 x10 cm row spacing in month of June and harvesting in October. The different organic manures and fertilizers were applied in band placement before crop sowing. The quantity of manures applied as per treatment on basis of proximate analysis of manures.

Soil samples from 0-15 cm depth were collected in triplicate, from individual plots during critical growth stages of soybean. Care was taken during sampling for maintaining homogeneity. The soil was kept in the well labelled polythene bags, tagged and brought to the laboratory. After processing suitable amount (500 g) of soil was stored in incubator at 30ºC for the analysis. The soil samples were analysed for bio-chemical properties of soil by using standard methods. Microbial population was determined by serial dilution plating method [4]. Phosphatase (alkaline and acid) were analysed following the method of Eivazi and Tabatabai[5]. Dehydrogenase was estimated as described by Casida *et al*.[6] Grain and straw yields were recorded at maturity of crops. All the experimental data of soil, plant and soil microorganisms were statistically analyzed to draw conclusion of significance by using the methods prescribed by Panse and Sukhatme[7].

RESULTS AND DISCUSSION

3.1: Effect on microbial population:

The data revealed that the microbial population *viz.*, PSB, bacteria, fungi and actinomycetes were found to be increase significantly due to IPM treatments to soybean (**Table 1).**The IPM treatment of application of manures and fertilizers as per STCRC equation of soybean with FYM (T_3) treatment significantly recorded highest bacterial (31.03 x 10^6 cfu g^{-1} soil), actinomycetes (15.47 x 10^4 cfu g^{-1} soil), PSB (22.55 x 10^4 cfu g^{-1} soil) and fungi population (13.48 x 10^5 cfu g^{-1} soil); respectively at soybean harvest. Amongst IPM treatments (T_5 to T_9), the application of manures and fertilizers AST RD NK + P- 25% P_2O_5 through PMC and 75% through SSP (T_8) treatment showed higher bacterial, actinomycetes, PSB and fungi population. In respect of only chemical fertilizer treatments T_2 and T_4 observed lower microbial population than other all IPM treatments. These findings are in the line of the earlier observations made by Mukharjee *et al.*[8] . Similar findings have also been reported by Selvi *et al*.[9] .

Table 1: Effect of IPM on microbial population at soybean harvest

Treatment	Bacteria (x106cfu g-1 soil)	Actinomycetes (x104 cfu g-1 soil)	PSB (x104 cfu g-1 soil)	Fungi (x105 cfu g-1 soil)
T1	9.47	6.56	4.52	4.20
T2	15.26	8.64	13.52	6.58
T3	31.03	15.47	22.55	13.48
T4	13.20	7.56	9.90	6.00
T5	25.32	13.06	19.99	9.33
T6	23.05	11.72	16.48	8.67
T7	21.79	14.52	15.58	7.50
T8	27.14	10.89	19.55	12.81
T9	18.24	12.97	14.86	7.00
S.E.(m)+	1.06	0.61	1.00	0.41
C.D. at 5(%)	3.17	1.83	3.00	1.22

3.2 Effect on enzyme activities:

3.2.1 Dehydrogenase: The significant variation in the activities of soil dehydrogenase after harvest of soybean was observed due to IPM treatments to soybean (Table 2). After harvest of soybean, the observed range of DHA was 9.96 to 27.94 μg TPF g^{-1} soil 24 hr^{-1} due to various IPM treatments to soybean. The significant highest (27.94 μg TPF g^{-1} soil 24 hr^{-1}) DHA value was noticed by the treatment of application of manures and fertilizers as per STCRC equation of soybean with FYM (T_3) treatment to soybean. Among the treatments (T_5toT_9), where 25% P_2O_5 was substituted through various manures, the treatment T_8 in which 25% P_2O_5 was substituted through PMC was recorded highest (26.95 µg TPF g^{-1} soil 24 hr^{-1}) DHA enzyme activity. However, Only inorganic fertilizer treatments T_2 and T_4 observed lower (15.89 and 13.88 µg TPF g^{-1} soil 24 hr^{-1}) DHA activities than other all IPM treatments. The observations in present study on organic carbon content, microbial population and DHA values under various treatments of IPM after harvest of soybean are strongly supported by the earlier reports of Frankenberger and Dick[10] and Nannipieri *et al.*[11].

3.2.2 Acid and alkaline phosphatase: The application of manures and fertilizers as per STCRC equation of soybean with FYM treatment was significantly superior over all the treatments in respect of both acid and alkaline phosphatase activity (**Table 2**). The value of acid and alkaline phosphatase in the treatment T_3 are 17.97, 20.72, 17.85,14.91 and 55.28, 66.48, 57.54 and 34.39 µg PNP g^{-1} hr^{-1} under soybean growth stages *viz.*, 3rd trifoliate, flowering, pod filling and at harvest; respectively. The treatment 25% P_2O_5 substituted through PMC (T_8) is at par with T_3 treatment in acid phosphatase at different growth stages of soybean. As regards alkaline phosphatase, the IPM treatments 25% P_2O_5 substituted through PMC and FYM (T_8 and T_5) are at par with T_3 treatment during different growth stages of soybean. The value of acid and alkaline phosphatase in the treatment T_8 are 17.50, 20.48, 17.62, 13.42 and 54.65, 64.81, 55.94 and 33.30 µg PNP g^{-1} hr^{-1} under soybean growth stages *viz.*, 3rd trifoliate, flowering, pod filling and at harvest, respectively. However, only inorganic fertilizer treatments (T_2 and T4) showed lower acid and alkaline phosphatase activity than other IPM treatments during all growth stages of soybean.

The treatment as per STCRC equation of soybean with FYM added higher quantity of FYM. Due to more organic matter it increases the moisture holding capacity of soil. Since soil microbial activity is positively correlated with soil water potential [12]. The activity of enzymes can be attributed to microbial origin developed during decomposition of organic sources of nutrients. Addition of organic sources acts as good source of carbon and energy to heterotrophs by which their population increased with an increase in enzymatic activities. Similar relationships between organic carbon and enzymatic activities were reported by Bohme and Bhome[13]. Balanced nutrition of crop responsible for better proliferation of root (rhizosphere) was responsible for the maximum activity of enzymes. These findings corroborate the findings of Tarafdar and Rao[14] who have reported maximum activity of DHA and alkaline phosphatase in the rhizosphere of legume, Pearl millet, Brinjal, Cauliflower and Chilli.

However, it has been suggested that the rates of synthesis, release and stability of acid and alkaline phosphatase by soil microorganisms are dependent on soil pH, so alkaline phosphatase activity is induced in high pH soils [15,16]. In general, highest acid and alkaline phosphatase activity in soybean was observed under T_3 treatment and occurs the highest rate at 50 % flowering stage. The highest acid phosphatase activity under treatment T_3 might be due to increase in substrate like organic P in soil.

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Table 2: Effect of IPM on activity of dehydrogenase, acid and alkaline phosphatase enzyme at various growth stages of soybean

Treatment	Dehydrogenase (µg TPF g^{-1} soil 24 hr^{-1})	Acid phosphatase (µg PNP g^{-1} soil hr^{-1})				Alkaline phosphataes enzyme (µg PNP g^{-1}soil hr^{-1})			
		3rd trifoliate	50% Flowering	Pod filling	At harvest	3rd trifoliate	50% Flowering	Pod filling	At harvest
T_1	9.96	9.65	10.47	8.84	7.89	36.88	42.84	34.15	19.17
T_2	15.89	13.61	14.31	11.56	9.99	45.60	53.88	42.67	23.87
T_3	27.94	17.97	20.72	17.85	14.91	55.28	66.48	57.54	34.39
T_4	13.88	13.77	14.05	11.38	9.84	43.25	52.02	41.60	21.90
T_5	25.41	15.90	19.86	15.96	12.94	53.14	63.59	53.49	32.91
T_6	22.58	15.36	18.12	14.91	11.56	53.70	62.12	51.86	31.67
T_7	21.57	14.61	15.67	13.69	11.29	50.72	60.01	48.65	29.02
T_8	26.95	17.50	20.48	17.62	13.42	54.65	64.81	55.94	33.30
T_9	19.21	14.10	15.04	12.88	11.05	50.17	56.97	45.58	28.36
S.E.(m)±	0.69	0.34	0.37	0.38	0.34	0.86	1.11	1.07	0.64
C.D. at 5(%)	2.06	1.03	1.12	1.14	1.01	2.58	3.32	3.22	1.92

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CONCLUSION

On the basis of results, it was concluded that integrated phosphorus management through application of manures and fertilizers as per STCRC equation with FYM to soybean found highest microbial population, dehydrogenase, and acid and alkaline phosphatase enzyme activities in soil under soybean crop.

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